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SELECTING FIRE CONTROL PLANNING LEVELS BY BURNING INDEX FREQUENCIES

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How do you pick the base level of burning conditions for planning a fire control organization? Hiring and equipping full-time crews to handle the worst possible situation is obviously not economic, for extreme burning conditions occur infrequently. The more realistic practice is to set up a full-time organization adequate for normal or somewhat above normal burning conditions and then fill in with emergency crews when the situation demands. The planner knows the resource values and production goals he must protect. His problem is to decide on a cut-off point for the size of full-time and emergency force he can maintain economically.

Selecting the point between normal and above normal has always been a problem. Planning concepts for fire control organizations have long been tied to normal burning conditions (Dubois 1914, Hornby 1936). Worse-than-average conditions were recognized to exist, but the severity of burning conditions could not be determined until after the fire season. Then, as Show and Kotok (1930) suggested, severity was described by the percentage of fires reaching over 10 acres in size and the total area burned in the most difficult years. Show and Kotok stressed the importance of aiming protection effort at controlling fires under average worst conditions but had no burning index to serve as a yardstick. More recent fire control planning, as in Canada, relates organization plans to average burning indexes (Beall, 1950). The problem in planning, though, is to measure above-average conditions.

One method arbitrarily took the "average worst day" as the planning base for "average bad" conditions. The approach was first to

select an "average worst year"--defined as the third worst in the last 10 years as determined by the sum of daily burning indexes. Then for this year the average burning index of the worst 15 percent of the days was computed and taken as the base level.

This paper reports a method of selecting the planning base which tells the planner the probable frequency of a given burning index. It was devised for use with the California fire danger rating system, in which the burning index is rated on a scale of 0 to 100 and expresses the expected fire spread and intensity as influenced by weather. The index, therefore, is a good measure of relative job size--the higher the index, the more men and equipment will be needed to meet a desired fire-control goal in a given period. But a base such as the "average worst day" must not be applied too widely. If it is, it may not allow for geographical variations in climate.

The recent revision of the California fire danger rating system[1/] showed that an area the size of a national forest could have as many as seven different climatic regimes. When differences in weather, fuel, and topography were considered, the State as a whole had to be divided into 144 fire danger rating areas. Therefore, it was decided to use these divisions and compute base levels for fire control planning in each area in the California Region of the Forest Service.

The approach chosen was to determine from fire weather records the frequency of occurrence of each burning index. Data used were the daily burning indexes in a 6-year period, for July and August in northern and central California, and for July, August, and September in southern California. Each frequency was expressed as a percent of the total, the percents were cumulated, and the cumulated percents were plotted on arithmetic probability paper.

The resulting charts make it easy to see the frequency of "easy," "normal," or "bad" days. Planning levels can be set to cover a specified percent of the days during a fire season, and the burning index to be expected at this emergency point can be read from the chart. In the California Region, the planning level selected for the fire-control organization is 90 percent frequency; the corresponding burning index is called the "area base burning index."

The variability of planning levels can be illustrated by probability curves for four fire danger rating areas (figs. 1, 2, 3, and 4). In these areas, base indexes range from 12 in the north coast mountains, to 29 in the central coast, and to 17 and 43 in two adjacent southern

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1/ Schroeder, M. J. Development of the California fire danger rating system. Bul. Amer. Meteorol. Soc. 39(3): 178-9. (Abstract; paper presented at Amer. Meteorol. Soc. Session, A.A.AS. Logan, Utah, June 18, 1958.)

California areas. This means that in the central coast area, for example, 90 percent of the days will have a burning index of 29 or lower, and 10 percent of the days will have a burning index above 29.

The charts help the planner visualize weather differences between areas. The average burning index, which can be expected half of the time, is not as much alike in adjacent areas as one might expect. In the two southern California areas, for example, one averages 11 while its neighbor averages 26. The extreme conditions also differ markedly; in one the burning index is 46, in the other 88.

New charts need not be prepared if management is intensified to increase productivity. As the acceptable fire loss becomes less, the frequency level can be increased--say from 90 to 95 percent--and a new area base can be read from the chart.

Thus, cumulative probability curves give the planner flexibility. He can rate each area on its distinctive weather conditions, and he easily can adapt his organization to future changes in the job load. To produce such curves, good fire weather records are needed, and access to machine data processing is desirable. Frequency analysis by hand computation is a laborious, costly task.

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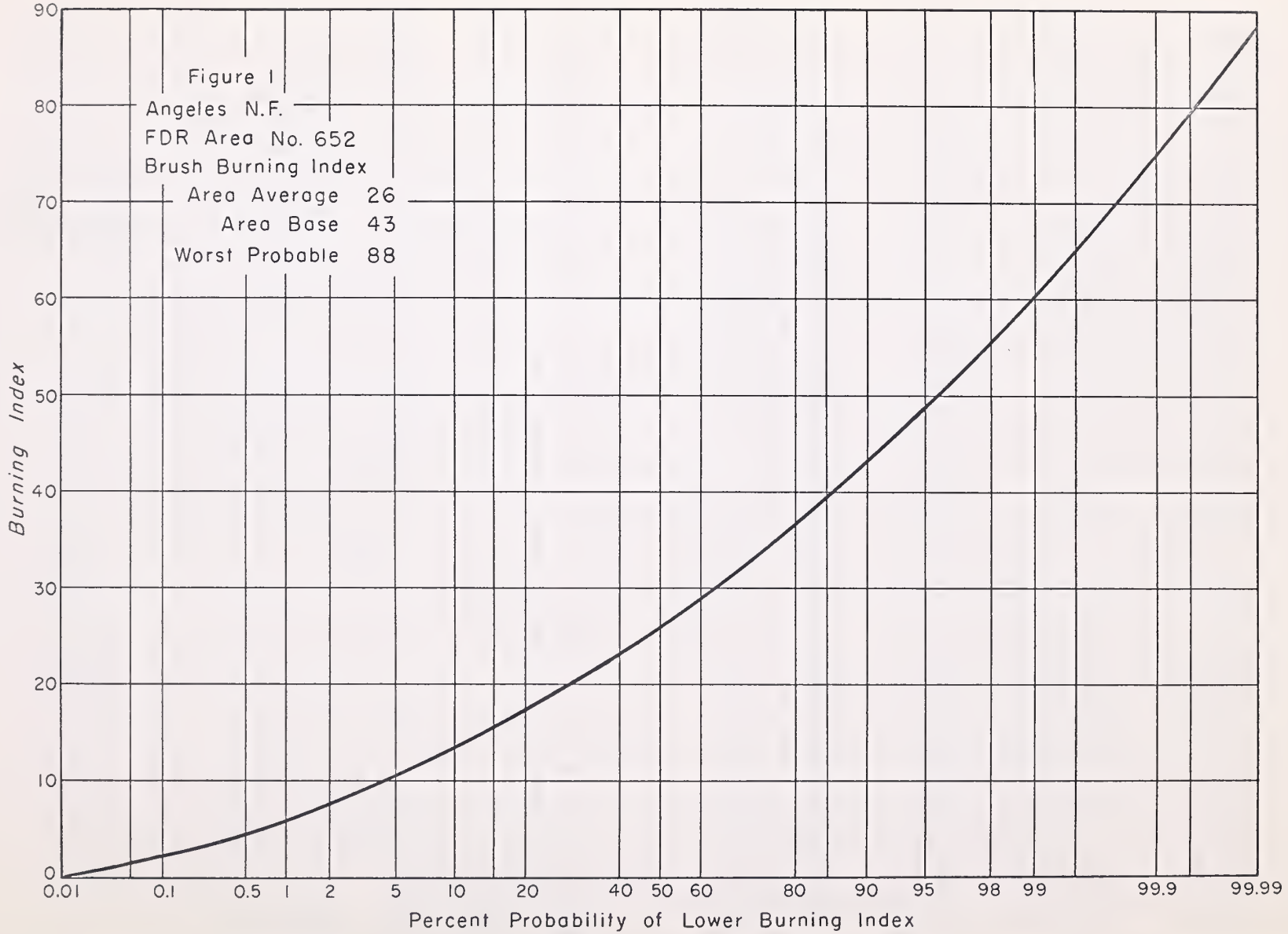
Figure 1
Angeles N.F.
FDR Area No. 652
Brush Burning Index
Area Average 26
Area Base 43
Worst Probable 88
Burning Index
0
10
20
30
40
50
60
70
80
90
0.01
0.1
0.5
1
2
5
10
20
40
50
60
80
90
95
98
99
99.9
99.99
Percent Probability of Lower Burning Index

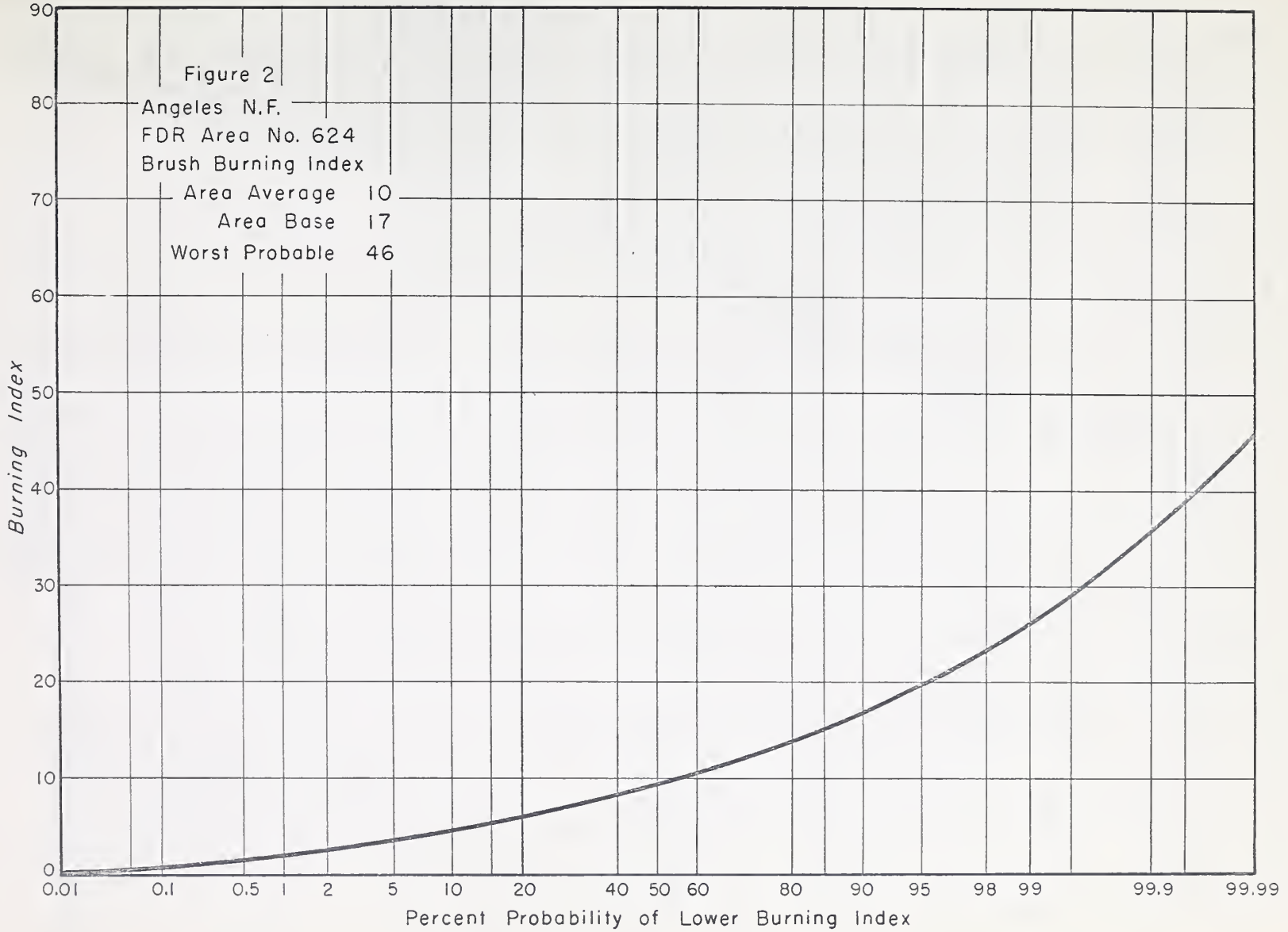
Figure 2
Angeles N.F.
FDR Area No. 624
Brush Burning Index
Area Average 10
Area Base 17
Worst Probable 46
Burning Index
0
10
20
30
40
50
60
70
80
90
0.01
0.1
0.5
1
2
5
10
20
40
50
60
80
90
95
98
99
99.9
99.99
Percent Probability of Lower Burning Index

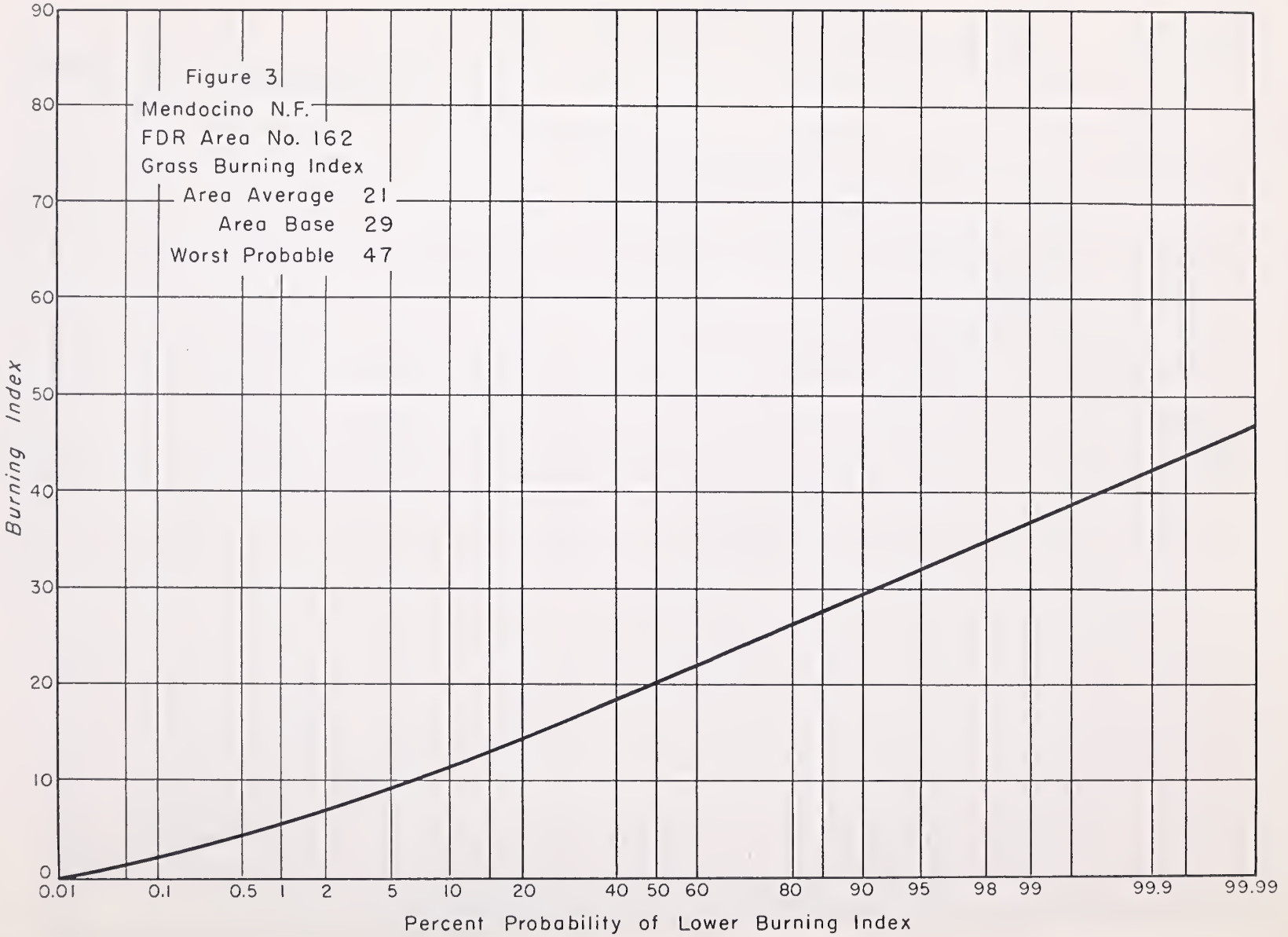
Figure 3
Mendocino N.F.
FDR Area No. 162
Grass Burning Index
Area Average 21
Area Base 29
Worst Probable 47
Burning Index
0
10
20
30
40
50
60
70
80
90
0.01
0.1
0.5
1
2
5
10
20
40
50
60
80
90
95
98
99
99.9
99.99
Percent Probability of Lower Burning Index

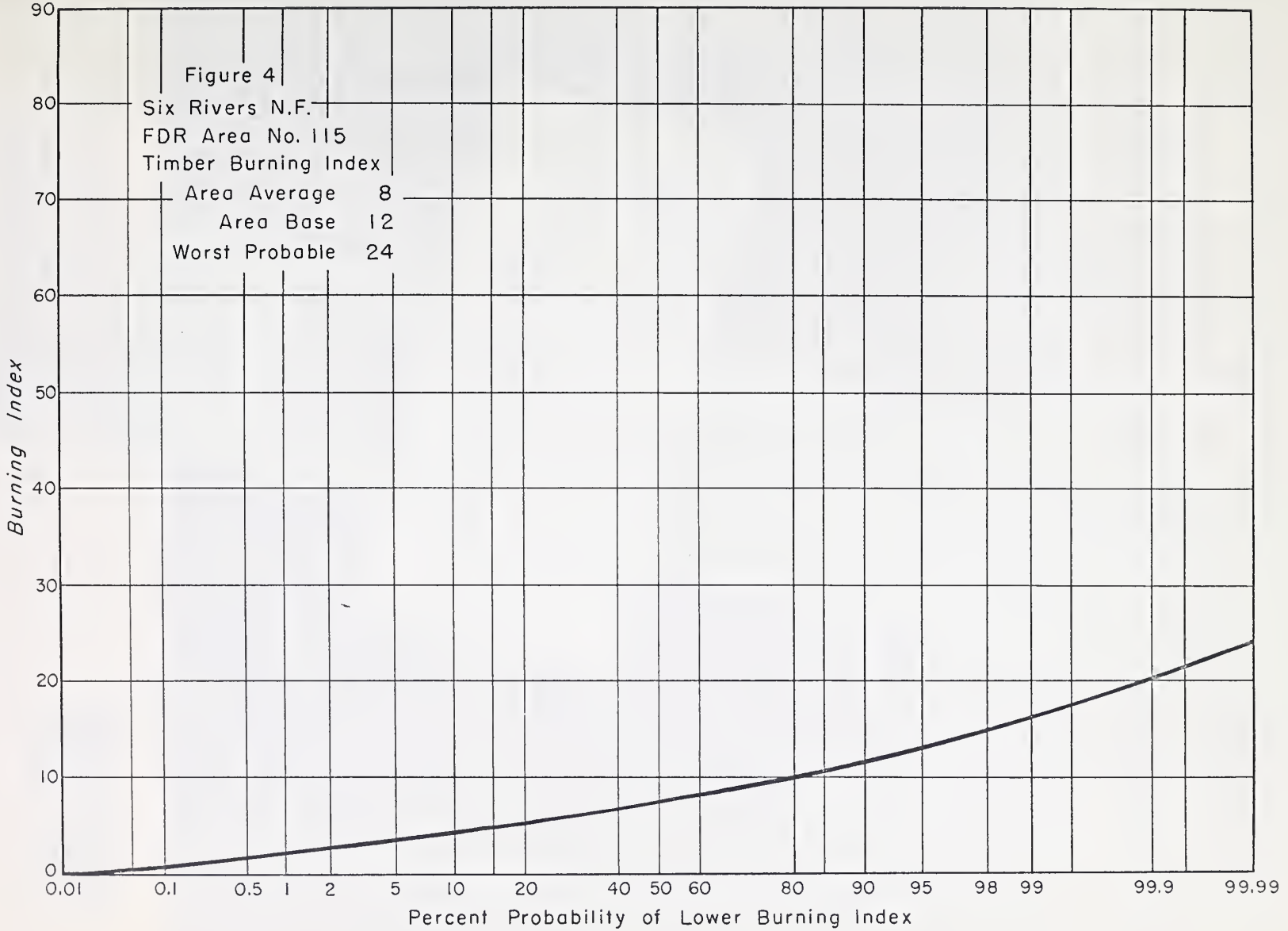
Figure 4
Six Rivers N.F.
FDR Area No. 115
Timber Burning Index
Area Average 8
Area Base 12
Worst Probable 24
Burning Index
0
10
20
30
40
50
60
70
80
90
0.01
0.1
0.5
1
2
5
10
20
40
50
60
80
90
95
98
99
99.9
99.99
Percent Probability of Lower Burning Index